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Enhancing Properties Of Concrete By Using Nano-Silica As A Partial Replacement Of Cement

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Abstract: Concrete is most commonly used construction material and it consumes huge amount of cement. Manufacturing of cement produces increasing CO2 emission which is harmful to the environment. Method used to reduce cement content in concrete is use of nano-silica and Flyash as a partial replacement of cement in concrete. Nanotechnology is one of the most promising areas of science. The use of nano materials in concrete is new revolution. Nano silica is presently used in concrete to modify its strength properties. In this study strength properties such as Compressive strength, Split tensile strength, Pullout strength of M40 grade of concrete with the use of nano silica 1.5%, 3%, 4.5%, 6%, 7.5% and 10% of constant rate of flyash as partial replacement of cement were studied. It was observed from the experimental study that concrete composites with superior properties can be produced using combination of nano silica and flyash.

Index Terms - Nano silica, Compressive strength, Split tensile strength, Pullout strength.

I. INTRODUCTION

Concrete is the most widely used construction material in the world. It is the mixture of cement, coarse aggregate, fine aggregate and water. Fresh concrete is freshly mixed material which can be moulded into any shape. It is one of the most widely used construction material and has a long history of use. Cement is the main ingredient in concrete. In manufacturing process of Portland cement, clinker in incinerated at about 1300ºC to 1500ºC resulting in emission of huge amount of CO2 into the atmosphere. Huge amount of CO2 emission causes very bad effects on the environment. So, nowadays a key issue for the construction industry is the need for sustainable concrete. Since last few decades concrete technology has experienced substantial advances, resulting in innovative use of supplementary additives and cementatious materials has developed new generations of concrete with improved properties. So in present work cement is replaced by nano-silica Fly ash to reduce cement content in concrete.

II.MATERIAL USED AND THEIR PROPERTIES

2.1.Cement

The Ordinary Portland Cement (OPC) of 53 Grade Birla Shakti cement is used. It has specific gravity of 3.11. The test conducted on cement was as per IS :12269-1987.

Table-1: Properties of cement

Sr. No.	Characteristics	Values obtained
1	Normal Consistency	33 %
2	Initial Setting Time	52 min
3	Final Setting Time	285 min
4	Specific Gravity	3.11
5	Fineness	4.8

2.2. Fine aggregate

Fine aggregate is used for this study was local river sand confirming to zone-II of IS: 383-1970.

Table-2: Properties of Fine Aggregate

Sr. No.	Characteristics	Value obtained
1	Type	Uncrushed
2	Specific Gravity	2.65
3	Total Water	0.65%
4	Fineness Modulus	2.5
5	Grading Zone	II

2.3 Coarse aggregate

Locally available coarse aggregate having the maximum size of 20 mm was used in our work. The aggregates were tested as per Indian Standard Specifications IS: 383-1970.

Table-3: Properties of Coarse Aggregate

Sr. No.	Characteristics	Value obtained
1	Type	Crushed
2	Maximum size	20 mm
3	Specific Gravity	2.76
4	Water Absorption	0.995%

2.4 Nano Silica

Colloidal nano silica obtained from "Bee-Chem" Chemicals Ltd, Kanpur.

Table-4: Properties of Colloidal Nano silica

Sr. No.	Characteristics	Value obtained
1	Parameter	CemSynXTX
2	Active Nano content	30 – 32%
3	pH(20 ° C)	9 – 10
4	Specific Gravity	1.20 – 1.22
5	Particle Size	5 – 40 nm

2.5 Fly ash

Fly ash of grade P-60 is used as partial replacement to the cement. Flyash is obtained from "DIRK India Pvt. Ltd.", Nashik, Maharashtra. Fly ash is guaranted to meet the physical and chemical requirements of IS 3812 PART 1.

2.6 Water

Potable water confirming to IS: 456-2000 is used for casting and curing.

III.METHDOLOGY:

3.1 Mix Design

To investigate the effect of nano-silica on the properties of conventional concrete the mix design is done according to IS 10262:2009. Strength properties of M40 grade concrete were studied.

3.2 Casting of test specimen

In present study the specimen of standard cubes of size 150 X 150 X 150mm, cylinders of size 150mm diameter and 300mm length are casted . Cube specimens were tested after 3, 7, 28 days of curing. And cylinder specimens were tested after 28 days of curing.

1) Mixing

Measured quantities of coarse aggregate and fine aggregate were spread over an impervious concrete floor. The dry OPC were spread out on the aggregate and mixed thoroughly in dry state turning the mixture over and over until the uniformity of color was achieved. Water was measured exactly and it was thoroughly mixed to obtain homogenous concrete. The mixing shall be done for 10 to 15 minutes.

2) Placing and Compacting

The cube, beam and cylinder moulds are cleaned and all care is taken to avoid irregular dimensions. The mix was placed in 3 layers and the layer was contacted using table vibrator to obtain dense concrete.

3) Curing

The test specimens were stored in a place free from vibration in moist air at 90% relative humidity and at temperature of 27+/ for 24 ½ hours from the time of addition of water to dry ingredients. After 24 hours the specimens are demoulded and immediately immersed in clean, fresh water tank for period of 3, 7, 28 days.

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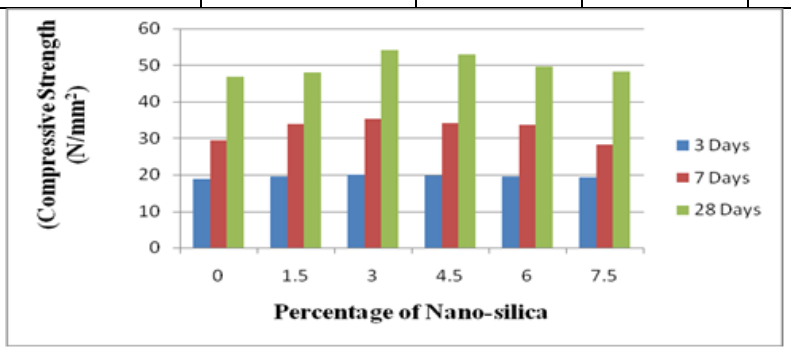
II. 4.1 RESULT

In Compression testing Machine, the top surface of machine is fixed and load is applied on the bottom surface of specimen. The rate of loading is gradual and failure (crushing) load is noted and compressive strength is calculated.

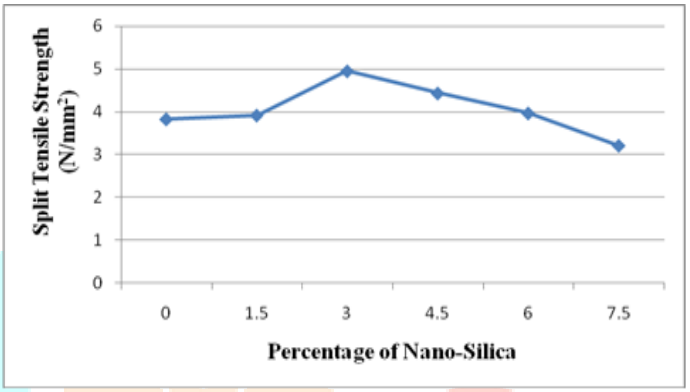
Sr. No.	Replacement of cement (%)		Compressive Strength (N/mm^2)		
	Nano silica	Fly ash	3 Days	7 Days	28 Days
1	0	10	18.87	29.49	46.71
2	1.5	10	19.55	33.89	47.89
3	3	10	20.05	35.21	54.12
4	4.5	10	19.65	34.11	52.89
5	6	10	19.42	33.61	49.67
6	7.5	10	19.27	28.33	48.12



Split Tensile Strength Test

For determining split tensile strength, cylinder specimens of size 150mm in diameter & 300mm in length are placed between the two plates of Compression Testing Machine. The load is applied at a uniform rate till the specimen failed by a fracture along vertical diameter. The failure load is noted and split tensile strength is calculated.

Sr. No.	Replacement of cement (%)		Split Tensile Strength (N/mm^2) 28 Days
	Nano silica	Flyash	
1	0	10	3.82
2	1.5	10	3.91
3	3	10	4.95
4	4.5	10	4.43
5	6	10	3.96
6	7.5	10	3.21



3. CONCLUSIONS

- The compressive strength was found 3.6%, 6.25%, 4.13%, 2.91%, 2.12% higher than that of conventional concrete when the cement is replaced by 1.5%, 3%, 4.5%, 6%, 7.5% by Nano-silica respectively and 10% Fly ash at constant rate for the age of concrete 3 days.
- The compressive strength was found 14.92%, 19.39%, 15.66%, 13.97% higher than that of conventional concrete when the cement is replaced by 1.5%, 3%, 4.5%, 6% by nano-silica respectively and 10% Fly ash for the age of concrete 7 days.
- The compressive strength was found 4.09% lower than that of conventional concrete when the cement is replaced by 7.5% nano-silica and 10% Fly ash for the age of concrete 7 days.
- The compressive strength was found 2.53%, 15.86%, 13.23%, 6.33%, 3.01% higher than that of conventional concrete when the cement is replaced by 1.5%, 3%, 4.5%, 6%, 7.5% by Nano-silica respectively and 10% Fly ash for the age of concrete 28 days.
- Split Tensile strength of nano-silica and Fly ash based concrete was higher by 2.35%, 29.58%, 15.96%, 3.66% than that of conventional concrete for the replacement of 1.5%, 3%, 4.5%, 6% at the age of concrete 28 days. For further increased in the percentage of replacement at 7.5% Split Tensile strength was decreased by 16.23% than that of conventional concrete.
- The pullout strength was found 4.19%, 13.22%, 17.31%, 22.04%, 0.005% higher than that of conventional concrete when the cement is replaced by 1.5%, 3%, 4.5%, 6%, 7.5% by Nano-silica respectively and 10% Fly ash for the age of concrete 28 days.
- Nano-silica based concrete gives more strength than conventional concrete.

3.3 REFERENCES

[1]. A.Boshehrian and P.Hosseini, (2011), "Effect of nano-SiO2 particles on properties of cement mortar applicable for ferrocement elements." Concrete research letters.
[2]. L. Senff, D.M. Tobaldi, S. Lucas, D. Hotza, V.M. Ferreira, J.A. Labrincha, (2012), "Formulation of mortars with nano-SiO2 and nano-TiO2 for degradation of pollutants in buildings". Composites: Part B 44 (2013) 40–47
[3]. Hongjian Dua, Suhuan Du, Xuemei Liu (2014), " Durability performances of concrete with nano-silica". Construction and Building Materials 73 (2014) 705–712
[4]. Mainak Ghosal and Arun Kr Chakraborty (2015), "A Comparative Assessment of Nano-SiO2 & Nano-TiO2 Insertion in Concrete." European Journal of Advances in Engineering and Technology, 2015, 2(8): 44-48
[5]. Alaa M. Rashad (2013), "Effects of ZnO2, ZrO2, Cu2O3, CuO, CaCO3, SF, FA, cement and geothermal silica waste nanoparticles on properties of cementitious materials – A short guide for Civil Engineer." Construction and Building Materials 48 (2013) 1120–1133
[6]. Alaa M. Rashad (2013), "A comprehensive overview about the effect of nano-SiO2 on some properties of traditional cementitious materials and alkali-activated fly ash." Materials and Design 52 (2013) 143–157
[7]. IS 10262-2009.
[8]. IS 456: 2000.
[9]. Gambhir, "Concrete Technology Theory and Practice."
[10]. T. Ashwini Reddy1,Madan Mohan2, Dr. Sreenatha Reddy, "Effect of Nano Silica on Mechanical Properties of Conventional Concrete: A Case Study" International Journal of Applied Sciences, Engineering and Management ISSN 2320 – 3439, Vol. 03, No. 06, November 2014, pp. 36 – 39
[11]. S. Tanveer Hussain, K.V.S.Gopala Krishna Sastry, "Study of strength properties of concrete by using micro silica and nano silica." IJRET eISSN: 2319-1163 | pISSN: 2321-7308.
[12]. Reshma, Dr.S.Siddirajulu, "An Experimental Investigation on Concrete with Nano Silica and Partial Replacement of Cement with Flyash"International Journal of Science and Research (IJSR) ISSN (Online): 2319-7064 Index Copernicus Value (2013): 6.14
[13]. Binsar Hariandja, Iswandi Imran, Ivindra Pane , Jonbi ,"The Use of Nanosilica for Improving of Concrete Compressive Strength and Durability", Applied Mechanics and Materials Vols.204-208, pp-4059-4062.